

Investigations on Coral Skeletal Density:

Coral Density and Sclerochronology

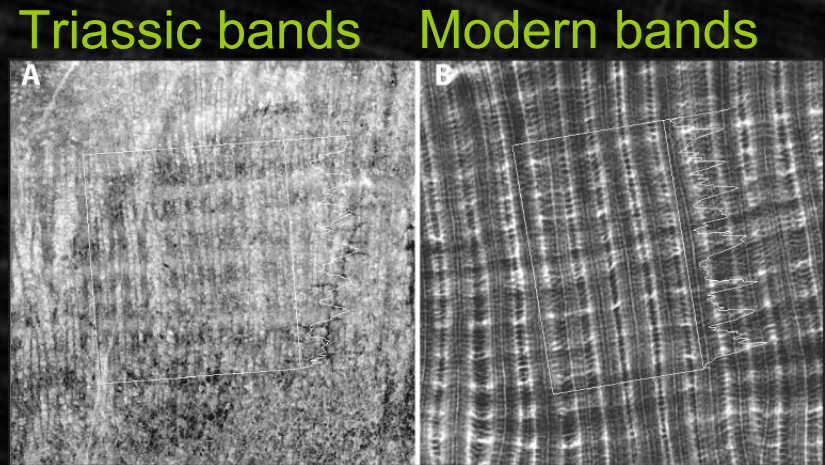
Caribbean Salinity Experiment (CASE)
Coral Coring Cruise

Richard E. Dodge and Kevin P. Helmle



Sclerochronology

- Density banding in corals
- A brief history:
 - Jurassic (144 ma) and maybe Triassic (230 ma)
 - 1934 T.Y.Ma reports annual patterns in skeleton
 - 1958 Nuclear testing at Eniwetok Atoll (+ 13 yrs)
 - 1971 Annual nature of density banding confirmed

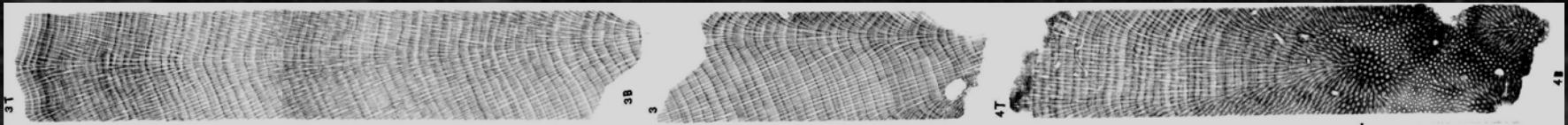


(Knutson *et al.* 1972)



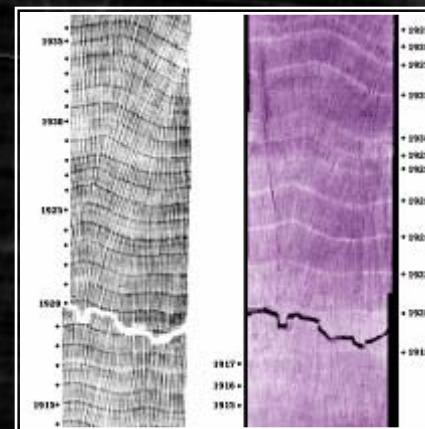
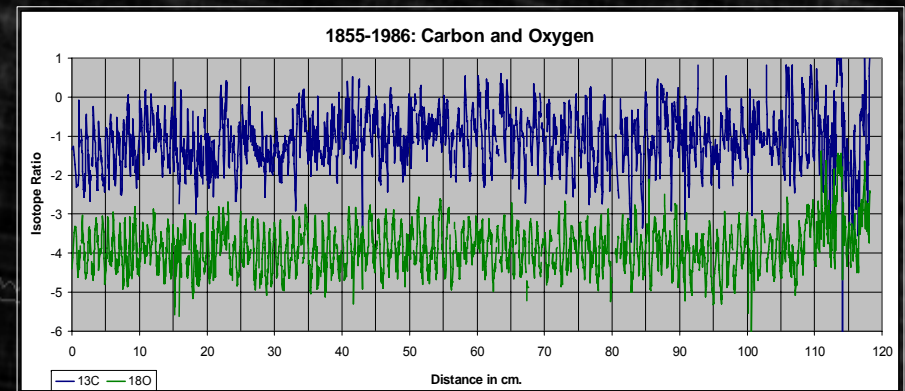
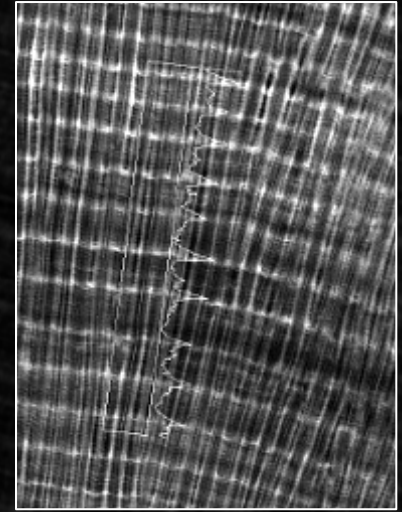
Coral Density Banding

- Skeleton has **annual bands** that provide record of growth over time
- Variations in growth rate reflect **environmental influence**
- Chronological reliability provides a **framework for interpreting impacts**
 - Anthropogenic
 - Climate Change



Coral skeletal records

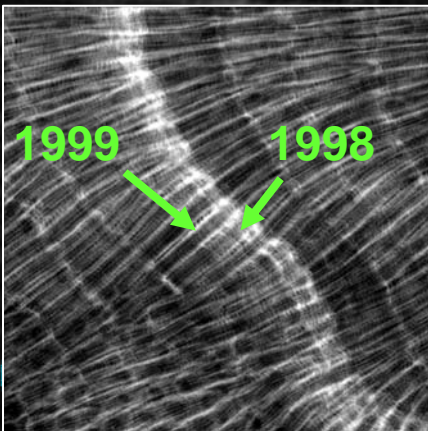
- Annual density banding
 - Extension, density, and calcification
- Isotopic ratios
 - Carbon ($\delta^{13}\text{C}$)
 - Oxygen ($\delta^{18}\text{O}$)
- Elemental ratios
 - Sr/Ca, Mg/Ca, etc.
- Skeletal fluorescence
- Skeletal stress bands



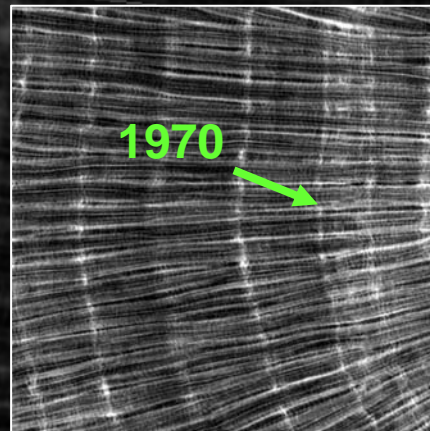
Stress Bands from Hot or Cold Temperatures

- Stress bands:
 - Decreased extension and increased density
 - Distinctly lighter bands on X-radiograph
- Examples from:
 - 1998-99 stress band following 1997-98 mass bleaching
 - 1970 stress band following cold 1969 winter

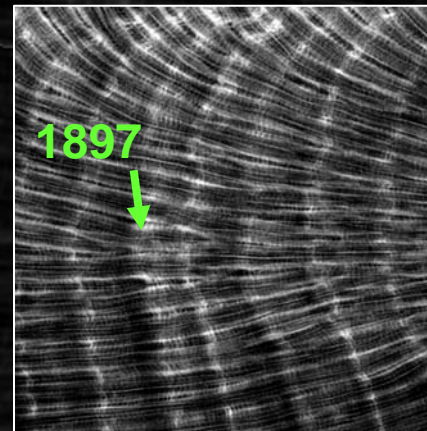
Hot



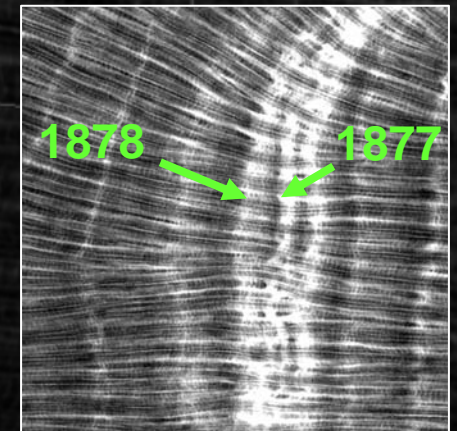
Cold



Cold?

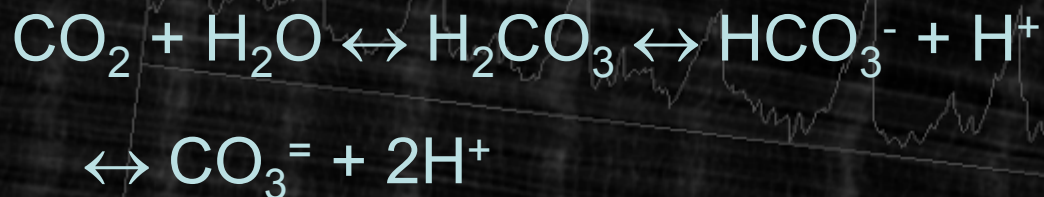


Hot?



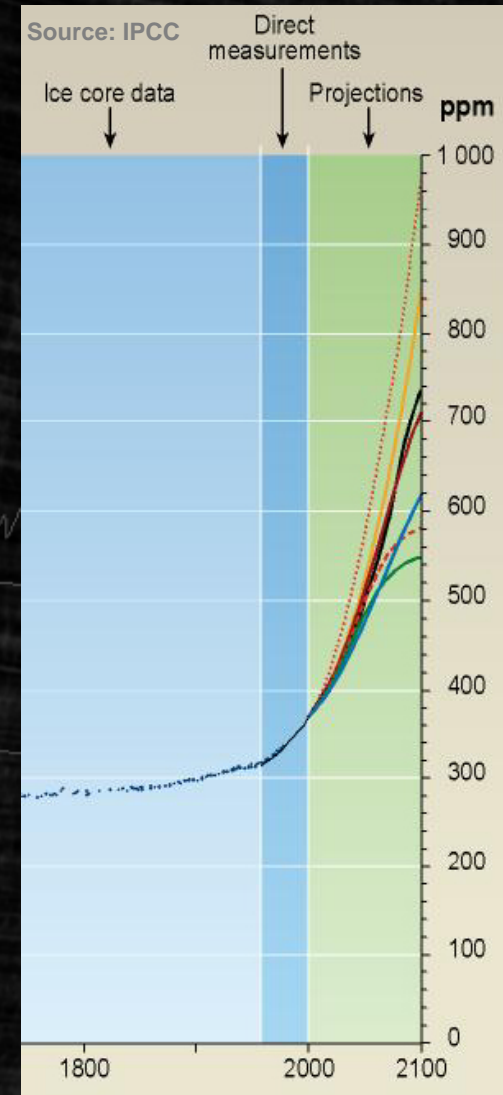
Carbon Dioxide and Calcification

- CO₂ levels are consistently predicted to rise
- Increase in CO₂ results in decrease of the calcium carbonate (CaCO₃) saturation state



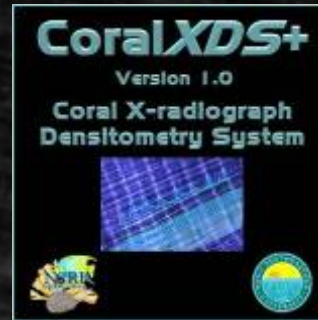
- Positive relationship between calcification and saturation state
- **Calculated values suggest that calcification declined ~10% over the last century.**

CO₂ Past, Present and Future



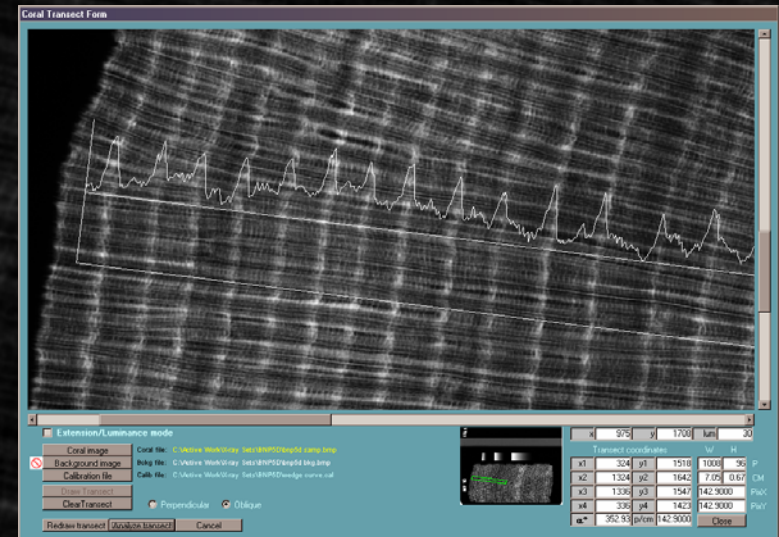
CoralXDS+

Kevin E. Kohler, Kevin P. Helmle, and
Richard E. Dodge

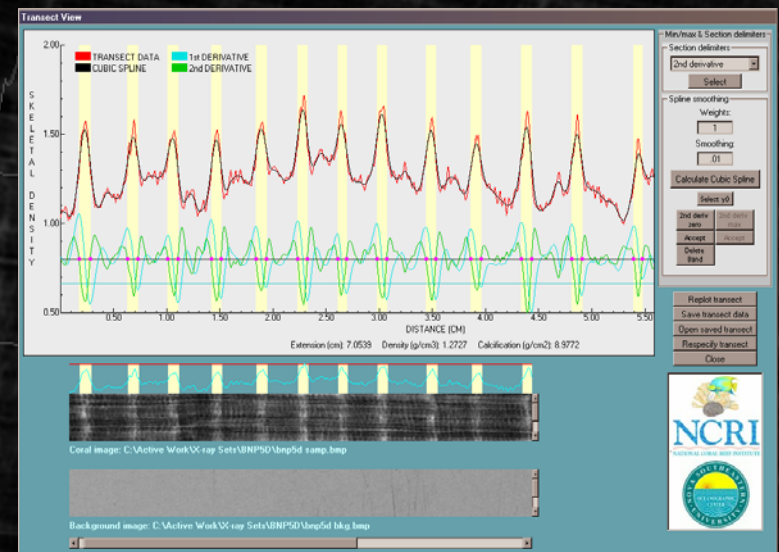


• Coral X-radiograph Densitometry System+

- Method of relating Optic Density to Skeletal Density
- Measurement of extension, density, and calcification
- Objective delimiting of annual signals on imported datasets
- Chronology confirmation across multiple datasets
- Cross-dating of annual signals within a core using multiple datasets

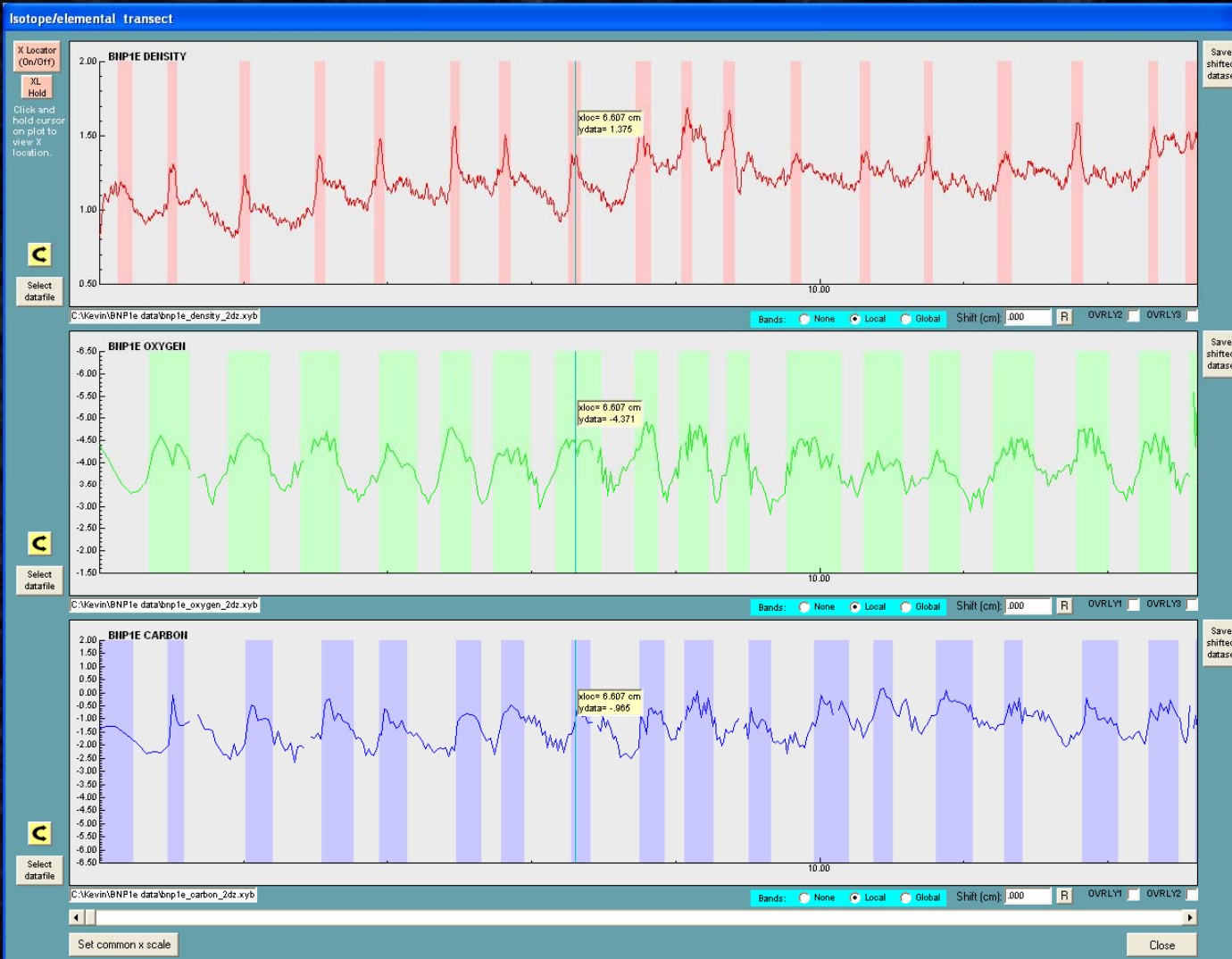
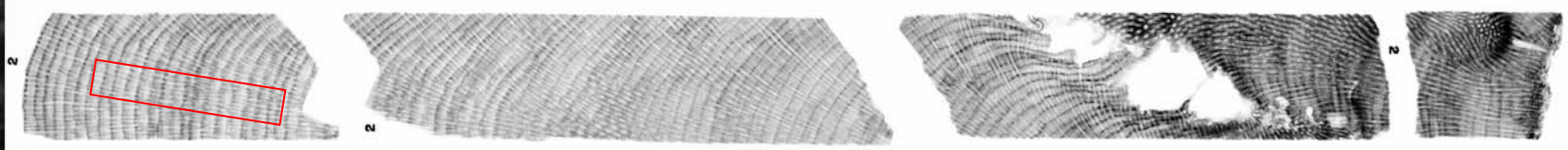


Coral image with density transect



**Band delimiters on density profile
and coral transect image**

Multi-proxy Approach in CoralXDS+



Density

Provides coral growth rates

$\delta^{18}\text{O}$

Proxy for salinity and temperature

$\delta^{13}\text{C}$

Indicator of photosynthetic rates, temperature and fossil fuels

CASE Cruise 2002

Caribbean Salinity
Experiment (CASE)

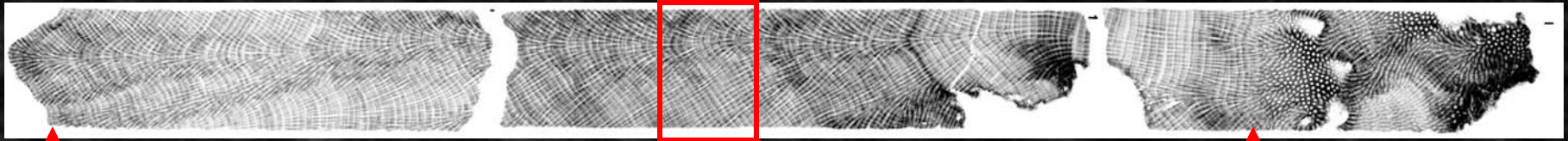
52 day cruise of the
Windward and
Leeward Islands

Collected 38 coral
cores:

Montastraea faveolata

Siderastrea siderea





2002

1838

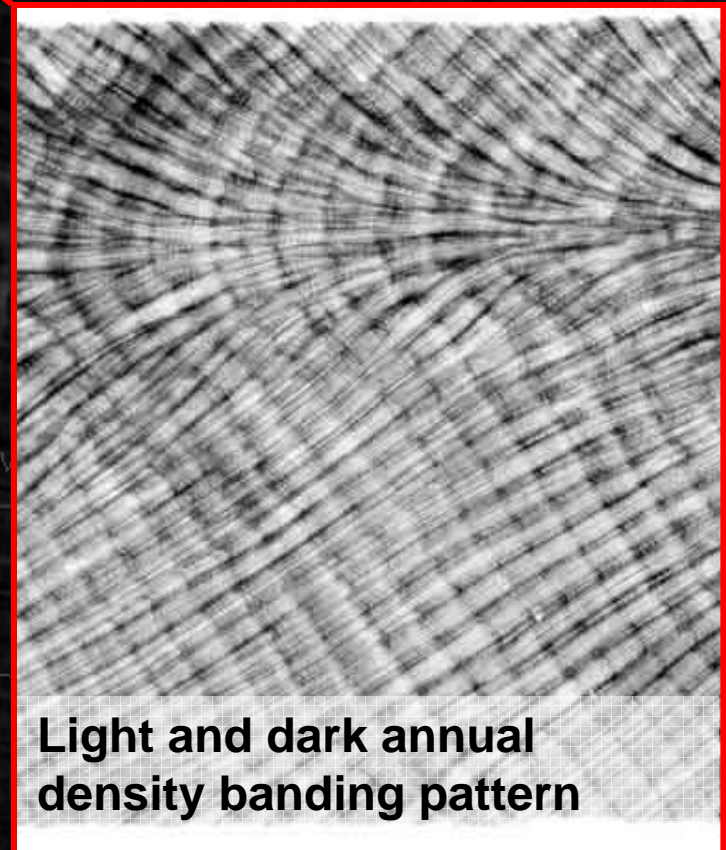
CASE Cruise

Core 18
Guadeloupe
(*Montastraea faveolata*)
2002 to 1838

165 year growth record

Collection information, site
map, and X-radiographs for
each core are catalogued at:

<http://www.nova.edu/ocean/ncri/case/cores/index.html>

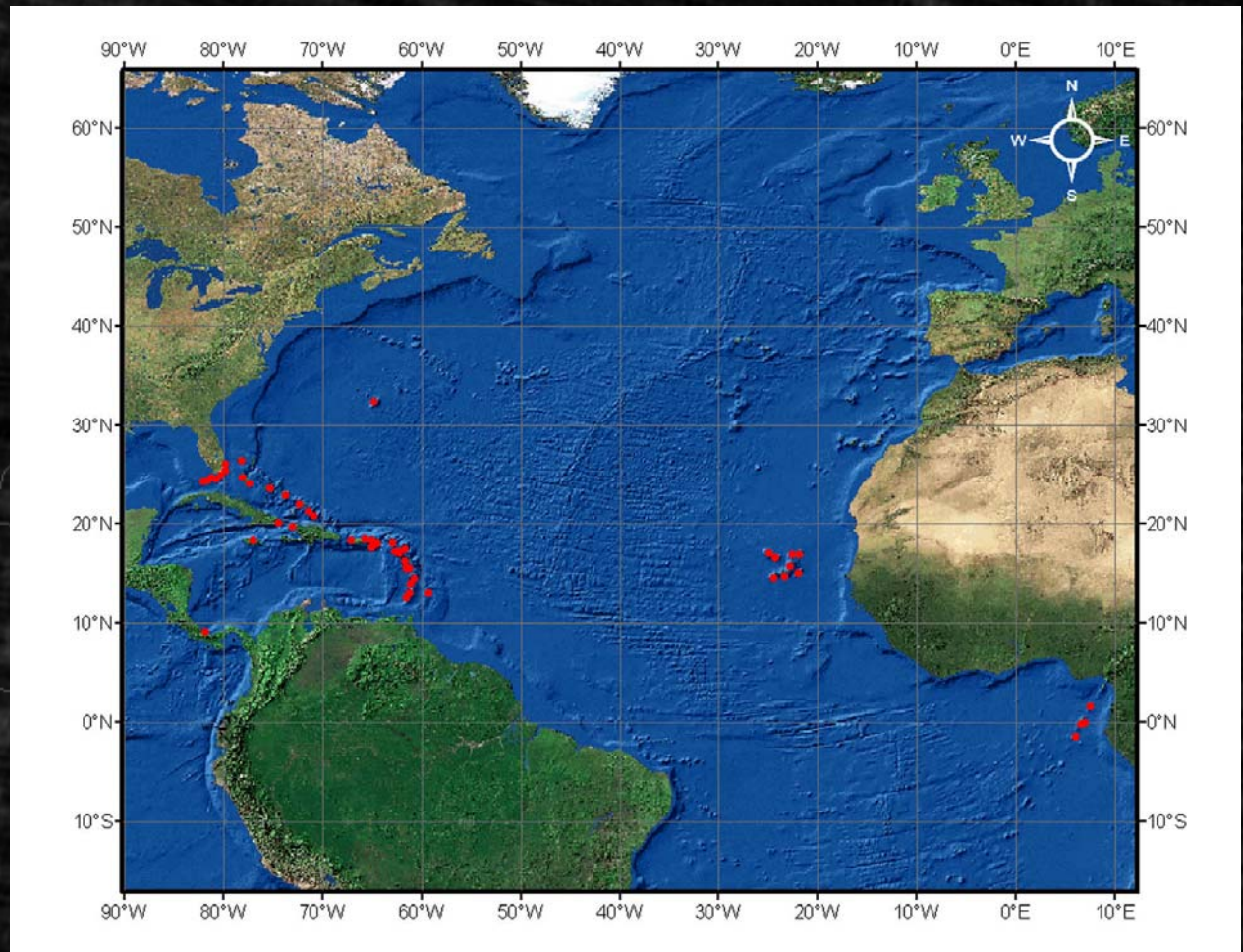


Light and dark annual
density banding pattern



Extent of NCRI Coral Archive

- 300+ coral samples
- 15° latitudinal range
 - equal to range of Great Barrier Reef
- Hundreds of years of growth and proxy climate records
- Allows continued testing of hypotheses on global change



• Current Coral Samples

